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ON THE URGENCY OF RESEARCH ON THE GREAT PORTAL TO DISEASE IN THE BODY[1]

IN selecting as the subject of my address on this occasion the urgency of research in a line along which little progress has been made, I am led to do so by considerations which I think will appeal to many of my hearers. It is, first of all, one which is of transcendant importance as an antecedent to any great advance in scientific medicine in the near future. On looking over the road on which so much progress has been made in the last forty years, one cannot but be impressed with the idea that all the old lines of research have been developed as far as they are capable of yielding results commensurate with the expenditure of time and energy given to them and that we are now in the stage of diminishing returns. The record since 1880 is crowded with discoveries in scientific medicine which will preserve from oblivion those who have made them, but unless some new lines of attack on great problems are to be thrown open the record for the next thirty or forty years will not have to its credit similar achievements. A recognition that our present methods of research in scientific medicine are not to give solutions of some of the great problems in disease which still confront us is already beginning to prevail. The distinguished clinician, Sir James MacKenzie, who has been during the last thirty years one of the keenest students, on the scientific side, of clinical medicine, is so convinced that scientific medicine as now developed is not going to yield any further conquests of importance that he has been compelled to seek a new line of research which may give results which will initiate a new and great advance in medical science. The new line which he has taken is the study of the beginnings of disease in the individual, that is, a close and very careful observation of

[1] Address of the vice-president and chairman of Section K—Physiology and Experimental Medicine, American Association for the Advancement of Science, Boston, December, 1922.

the changes in the normal condition long before the individual is impelled to consult his physician or is aware that anything is wrong with him. Sir James hopes that in this way a great amount of knowledge may be accumulated which will throw a flood of light on the origin of many of the diseases and thus inaugurate what may be justly called a great advance in medicine, comparable with any great advance made in the past.

It is hardly possible to doubt that a careful study of the organs of the body as they function in the supposedly normal individual, will, if systematically pursued, ultimately give a lore that will be of inestimable value in determining a fundamentally rational treatment of disease. The application of our present clinical methods is confined almost wholly to the manifestations of disease in its more or less pronounced stages and the features of the initial stages attract the attention of only a very few clinicians. Here, therefore, is an almost fallow field, where any one who enters to work steadily and systematically may reap a worthy reward for the toil of all his years. This combined with a closer, a more thoroughly scrutinizing study of the manifestations of disease in its later stages of development would result in a very great addition to our lore of medicine, and bring us back to the ancient Hippocratic rôle of closely observing and recording which, pursued for periods during the last twenty-four centuries, has made the Art of Medicine of the Western World an ornament of our civilization.

It is, however, doubtful if there is in our generation enough of those of the class of which Sir James MacKenzie is representative to make such an immediate advance in medicine as he believes possible. Progress is due to the activities of the almost inconceivably few. All the ideas, all the knowledge which determines our outlook on the physical world and the world of life of to-day are based on the results of the discoveries and inventions of less than one ten-thousandth of one per cent. of the population of the Western World during the last three thousand years. Even in the medical profession it is the inconceivably few to whom all progress in the past has been due. The rest have accepted and applied the results of the great discoveries of the few. Of the 400,000, more or less, who in Europe and America during the last century and a half have been members of the medical profession, how many have made, as a result of their researches and observations, great additions to our knowledge of the causation and treatment of disease? I would venture to estimate not more than thirty, that is, one out of every 13,000 in the ranks. These were the pioneers in the regions of the unknown to whom we owe the great generalizations which constitute the foundations of what we call medical science. Without their achievements there would have been no advance in it during the last three centuries and medicine would still be but a lore of impossible hypotheses and theories like that which darkened understanding amongst the physicians of the sixteenth and seventeenth centuries. There were indeed others who by their observations in their own limited field of activity added fact upon fact in verification of the great generalization and who by their support of these made their general acceptance possible, but they would not have been of service in any other way to medical science had it not been for the great discoveries of the pioneers.

To extend this science to-day, to make here and there great additions to it, pioneers of the same type are still required. Are such now in training, or beginning their career, or ready to launch some new line of extension?

Sir James MacKenzie does not apparently think there are or will be such, for his Newer Medicine is to owe its achievements to organizations the members of which will devote themselves to the observation and correlation of the facts which may be gained from a continuous, systematic study of the very earliest manifestations of alteration of function which mark the commencement of disease in the supposedly healthy individual. He is apparently extremely sceptical of the value of the laboratory by itself as a factor henceforth in the advancement of our knowledge on the treatment of disease. Research on the laboratory side is carried on by workers who, he holds, are out of touch with the problems in medicine and in consequence their contributions offer little in the way of a solution of these, which must be undertaken by the physicians themselves who are in immediate contact with the problems on the purely clinical side.

It must I think be admitted by all who are

in touch with the present laboratory methods associated with the diagnosis and treatment of disease that the effort spent in the development of them by a multitude of workers in laboratories and the narrow range of the results obtained make it appear as if the vast majority of investigators concerned believe the great problems that can be attacked successfully are all solved and that there remains only to be developed an ever more and more refined technique which will be concerned only with circumscribed problems such as the hydrogen ion concentration, basic metabolism, new reactions of the class of Widal, Schick and Wassermann, more exact methods for the determination of sugar, urea, uric acid, ammonia and other constituents of and metabolic products in the blood, and so on. These and like matters of limited interest and range of application constitute the vast majority of the problems which are now being investigated if the contents of the original papers published in the journals devoted to physiology, biochemistry and pathology give a trustworthy indication of the character of the research that is being carried on in these sciences to-day.

If even a new subject of more than ordinary importance is advanced there soon results a multitude of contributions on it, the great majority of which deal only with details while the central part of the problem is not attacked or only incidentally. An instance may be cited. On the vitamins, which are all important constituents of a normal diet and which were first made known sixteen years ago by Gowland Hopkins, there has been a vast amount of effort expended but chiefly or almost wholly on determining their distribution in different foodstuffs and the effects of diets, from which they are absent, on animals, all in a statistical or empiric fashion, while but little has been attempted or accomplished as to their constitution although a basic explanation of their action in the body can only be obtained when their chemical composition is accurately known.

Then there is the labor that is directed to the determination of hydrogen ion concentration in physiological media. From a survey of the multitude of contributions on this subject which have been made in the last five or six years one cannot but believe that an excess of emphasis has been placed on it which is not justified by the results obtained or any generalizations drawn from them. As much also may be said of the work that is done on a number of problems in immunology.

It must not be inferred from what has been said that I underrate the real value of the results of much of the work that has been done in these lines. I recognize that they have a value, but a value that is not commensurate with all the effort expended in obtaining them for it involves an emphasis on details which should be placed on important problems the solution of which would open new and fundamental lines of development in our knowledge of living matter in its normal condition and in disease. The emphasis placed on details is diverting the energies of a large number of young workers of promise away from the more important problems in the investigation of which they might develop a capacity for adding very greatly to our knowledge and thus achieve a career of distinction in research for themselves. This attention to details on such a large scale at the present time can be justified only on the plea that all the great or more important problems are solved. Even if they did appear to be, it is difficult to believe that a young potential Pasteur, Virchow, Lister, Koch, or Ehrlich would content himself with the investigation of such details and yet I believe there are such potentialities amongst the younger generation of researches who may easily be induced to devote all their energies to problems of outstanding importance.

It may be asked: Are there such important lines of investigation yet to be undertaken? My answer is that there are, and not a few, and that, further, more may eventually be found than are now conceived possible. The chemical constitution and the fundamental action of the vitamins are two of these. There are the questions concerning the nature and action of the bacteriophagic lysins, our knowledge regarding the existence of which is the product of the activities of several keen young workers during the last seven years. The interpretation of the character, origin and action of these lysins in dissolving bacteria will ultimately depend on the results of research to be carried on in the next few years. Meanwhile, it would appear that the bacteriophage is a factor in immunity, especially in the intestinal

tract, which may not be classed with the antibodies which hitherto have been regarded as the only or chief immunizing substances produced in the body to resist bacterial invasion. The bacteriophage question has, therefore, thrust on our attention problems of a high order of importance.

Behind all these problems there are at least several which concern the causation of a considerable number of pathological changes and alterations in function in the organs of the body. These problems are all related to the functions of the intestinal mucosa. Such functions are only very imperfectly known. One involves the absorption of the products of the digestion of the foodstuffs. In this absorption the mucosa has been, and is still too often, regarded as if it were only a physical membrane separating the blood from the intestinal contents, through which the peptones, amino-acids, glycerine and sugars diffuse to reach the vascular channels. What we have to set over against this physical concept are a few facts the significance, however, of which is not clear. Soaps and fats which are colloids enter and go through the epithelial cells of the mucosa and a number of proteins, those of egg yolk particularly, pass unchanged readily into them, but how the former and the latter are so taken up is still unknown or only dimly comprehended. The salts of iron and potash can be traced microchemically in their passage through the epithelium and the phenomena involved appear at first view to be caused by the simple forces of diffusion but on further consideration one must postulate that other and more important factors are concerned. We know, further, that the mucosa, especially of the upper half of the small intestine, secretes a number of ferments, such as erepsin, invertase, maltase, lactase, and the activator of trypsinogen, enterokinase, and that secretin, the hormone of the pancreas, is a product of the duodenal mucosa, but, except in the case of secretin, we do not know definitely what elements of the mucosa form them.

This, in brief, comprehends our knowledge of the activities of the intestinal mucosa and yet how exiguous it is in comparison with what may yet be obtained through careful and well-directed research. The mucosa is, in its properties and functions, something very much more than a physical membrane. Because its superficial layer is composed of living cells it is not, it cannot be, a passive element, for the cells have, as living units always have, the capacity to accept or reject whatever constituents of the chyle there may be and this capacity is exercised by them through the long life of the individual. They even maintain themselves against the invasion of bacteria of the ordinary type.

This epithelial membrane then has functions which make it unique, functions which are not performed by any other organ. It is the absorbent of practically all that goes to nourish the body, a rôle that involves a variety of activities assigned to no other class of cells in the body. It prevents also the passage through it of the ordinary bacteria of the intestinal cavity and of their products, toxic and otherwise, and therefore it must be regarded as the first line of defense of the body, at its most vulnerable point, against disease. As no other structure in the body is so much exposed, and constantly to bacteria and to invasion by them it is difficult to exaggerate its importance in this respect.

That the cells constituting this membrane, battling against hosts of bacteria and subject to the action of the products, many and varied, of putrefactive fermentation, may finally fail to "play up" must naturally be expected. Then pass into the circulation some or all of those elements which the cells in their fully normal condition do not absorb, or if they do absorb, do not transfer to the underlying tissues.

It is not too much to say that in this failure on the part of the epithelial cells an explanation may be found of the origin of a large number of diseases of the body. It is my firm conviction that arteriosclerosis, hepatic cirrhosis, acute yellow atrophy of the liver, nephritis in some of its forms, angina pectoris, senile dementia and dementia precox are all due to failure, more or less pronounced, on the part of the intestinal epithelial cell to play its normal part. In some cases this failure may develop suddenly as in acute yellow atrophy, in other cases it may involve a gradually lessened capacity of the epithelial cell to reject or neutralize the products of putrefactive action. That dementia precox has this origin is indicated by the facts that it is frequently associated with intestinal stasis more or less pronounced and that not unfrequently in this

disease there may be atrophy of the testes or ovaries, facts that can only be explained by supposing that not only this atrophy but the degeneration of the cortex are due to the action of toxins of intestinal origin. Senile dementia, when not of arteriosclerotic origin primarily, is probably due to a gradually lessened capacity of the intestinal cells to reject the toxic products of putrefactive fermentation.

The intestinal mucosa must then be regarded as the great portal to disease of the body. This portal may be completely closed as it is in the normal healthy condition of the mucosa or it may be gradually or suddenly pushed open and disease, chronic or acute, may result. If this portal could be kept closed always old age might be indefinitely postponed and bodily vigor maintained for a much longer period than it is now. There is no reason to suppose that the heart, the skeletal muscles, the liver, the kidneys, the nervous system and the endocrinous organs cannot function indefinitely if they are not subject to toxic action and in their normal condition they must be much less subject, through any other portal, to bacterial infections than they are when their condition is altered by the access of toxic material absorbed from the intestinal cavity. The complete closure of the great portal permanently maintained would greatly lessen the incidence of disease and increase the average length of life.

It is probable that excess in diet, especially in its protein constituents, may task the capacities of the epithelial cells and diminish their power to react normally, with the result that they allow to pass through them, and to the underlying tissues and the circulation, the products of intestinal putrefaction which in their healthy vigorous condition they do not permit to enter them. This would explain some of the pathological results of a high protein diet. It is also very probable that the primary and most important action of vitamins in diet is on the epithelial cells which, with the glandular structures below them, as McCarrison has found in his observations on animals fed on autoclaved food, undergo marked atrophic and necrotic changes, followed by an extensive invasion of the mucosa by bacteria. The changes which other organs show in avitaminosis have yet to be shown due directly and not indirectly to their deprivation of the vitamins. Once the Great Portal is thrown wide open, neuritis, degenerative changes in the pancreas, thyroid and spleen, atrophy of the testes and ovary, and hypertrophy of the pituitary and adrenals may be of toxæmic origin. Constipation also seems to be one of the earliest results of avitaminosis and its causation may be similarly explained.

The importance then of a thorough knowledge of the functions of the intestinal mucosa and especially of the epithelium covering it cannot be overestimated. To obtain that knowledge is to place us in a position from which we can make a great advance in the treatment of disease or in the prevention of it, comparable with any one of the great advances of the past in scientific medicine. That knowledge can only be obtained by a profound study of the epithelial cells themselves, of all the forces that are concerned in their normal activities, of the character of the proteins and other organic elements of which they are constituted, of the action of bacterial toxins on them and of their defence against them.

The attainment of all this knowledge is not to be an achievement of the very immediate future. That would require a number of specially trained investigators who would devote themselves to intensive research in this line for some years. Investigators of the kind necessary are rare. They would have to be trained as few are being trained to-day in physiology, biochemistry, or pathology and this could not be accomplished immediately. They should acquire an excellent knowledge of chemistry, organic, physical and colloidal, more especially of biochemistry, microchemistry, cytology and the physical forces that obtain and operate in, and on the surface of, fluid and colloidal systems. They must have also a good working knowledge of bacteriology and of the technique employed in immunological research. Only thus qualified would they be able to undertake research on the intestinal mucosa with any prospect of obtaining noteworthy results.

It may be held that the training of such researchers is an impossibility because it appears to postulate that each of them shall be as highly qualified in several sciences as a specialist may be in one of them. It may be

admitted that the training necessary to conduct successfully research in this line must be of a more thorough kind than is undergone by those of to-day who are preparing for a career in research in any one of the medical sciences, but it is not more than can be exacted of a capable student free, but under special direction, to give attention for a few years to special branches of the several sciences, the knowledge of which is required. That there are few so trained now is no indication that none can be. The training of physiologists, biochemists and pathologists has hitherto been largely determined by chance conditions. There has been no guidance in it and too often it has been of an elementary or very limited kind. Many of those so prepared have in their own specialties done considerable service in the way of research, but the problems that remain demand of those who attack them more thorough and wider knowledge along different lines and in consequence the preliminary training must henceforth be extended to cover all the different sciences or branches of them, a knowledge of which is concerned in such research.

Such a training would qualify as well for important lines of research in pathology, bacteriology, immunology, physiology, and pharmacology, for the highly trained worker is to be henceforth as necessary in research in these fields as he is in biochemistry, otherwise the yield in results of more than a narrow significance will be very scanty. Only thus can the blight of spelunculism in the medical sciences, which is now in prospect, be prevented.

To produce these researchers is the duty which must be undertaken by those in command of the various departments of these sciences in our leading universities. They must exact of the young students under their charge a higher standard of attainment if research in the causation and treatment of disease is to achieve greatly in the coming generation. The demand for investigators of this type will be urgent and insistent in the next two or three decades and the failure to train them will reflect on those controlling the advanced teaching in these sciences.

With even half a score of such highly trained researchers working in this new field in the next few years results would be obtained some at least of which would compare in importance with those which marked the history of medicine in the last seven decades. We would then have a greatly increased, perhaps a profound knowledge of the functions of the organ which serves as the Great Portal of disease in the body. This knowledge would make possible new and highly rational lines of treatment of a large number of diseases, it would enable us to lessen very greatly their incidence and with its aid a regimen might be devised which would delay in the individual senescence, and even death, it may be, indefinitely.

The call for research in this line is urgent, for only through it is another great advance in medicine possible.

A. B. MACALLUM

MCGILL UNIVERSITY

BAIRD, THE MAN[1]

THE policy of the Smithsonian Institution under Professor Henry was to disperse as widely and freely as possible the worked-up material, and to enlist in the process of elaboration the aid and enthusiasm of every American naturalist, each in his special field.

To make this policy a success, such as it eventually became, required qualifications of no ordinary kind. Not only must the work of mediation be guided by the most advanced biological science of the time, but the individual intrusted with it must possess a spirit of impartial liberality, tempered by a sound discretion in business methods; a thorough knowledge and just estimate of men; an untiring patience to meet the peculiarities and caprices of the independent and often one-sided specialists whose cooperation was essential; a geniality to enlist the willing but unscientific collaborator; and an instant detection of humbug in every guise. Providentially for the future of natural science in this country, the need and the man met in the selection of Professor Baird. In qualifications for the work he stood preeminent—head and shoulders above any man of his time, and perhaps above all other scientific men of any time. He joined

[1] One of the addresses given at the meeting in commemoration of the one hundredth anniversary of the birth of Spencer Fullerton Baird, held in the U. S. National Museum on February 3, 1923.

to a marvelous faculty for systematizing business a capacity for steady and continuous work only limited by his waking hours. His frank, genial and wholly unaffected manner put the scientist and the laboring man alike at ease. Always busy, he yet always seemed to have time for a friendly chat with every comer. His memory appeared an inexhaustible storehouse of facts on every subject where any desired datum lay ready for his use. He knew every specialist in the country. Not only did he hold amicable relations with scientists actually at work, but one might think there was not a school boy of extraordinary genius for birds' nesting or fishing on whom he could not lay his hands.

His appreciation of the workers did not stop with the recognition of the character of their scientific results. It seemed as if in his mind he had an epitome of all the characteristics of mind and habit of each and every man. In the constant necessity of selection for this or that task or post, which the always increasing scientific activity of the time rendered more frequent from year to year, he was very rarely mistaken in his judgment. In his position he was called upon to advise in nearly all government appointments which had a scientific bearing, direct or indirect; and the total number of selections which he determined during his career must have been many hundreds, and have included nearly every available person among the younger generation of students. The most surprising element in it all, to those cognizant of the details, was the calm impartiality which he brought to the task. No thought of self seemed to enter into his calculations. To best fit the purpose was his sole criterion, the purpose always being the promotion of science, and it was a very crooked stick indeed which was not fitted by him to some honorable service, as opportunity served. Those who felt themselves the objects of his personal regard sometimes halted for a moment in comical dismay, perceiving themselves frankly moved, like chessmen, in directions which they would not themselves have selected, and did not altogether like, almost as if they were perfect strangers; but an overwhelming sense of Baird's entire devotion to the promotion of science, his perfect unselfishness, and his incomparable good judgment, always carried the day, and the final outcome never discredited his generalship.

These characteristics would have made a great administrator anywhere, but there were other elements in the problem. It is not so hard to select deputies, aids and workers of every kind when the work of the selector and that of the designated person form duly subordinated parts of a general scheme, or the parts are so constituted as to be capable of purely independent elaboration. But in scientific work, as every one knows, the spirit of emulation is strong; men work often with a single object in view, and the glory of its first elucidation is necessarily for one alone. Doubtless the substantial amity and concord which have prevailed among American naturalists is in part due to their scattered distribution, the vast and, until recently, virgin fields open to research, and the consciousness that there is plenty of work to occupy profitably every willing student and as many more. In scientific as in economic competition the rivalry grows more intense as unoccupied ground diminishes. Nevertheless, from the earliest times of American science there have been controversies, and naturally these have been more active among the leaders. Baird himself having been one of the most prolific contributors to the literature of systematic zoology in the United States, it is evident that in promoting the studies of others, and in holding as a trust for the general benefit the vast collections which passed under his control, opportunities must have been numerous for giving precedence to the progress of his own researches rather than those of others engaged in the same lines. In such cases, we believe, he never hesitated, and the decision against himself was in more than one instance known by him at the time to be of pecuniary as well as scientific disadvantage to his own apparent interests. He never spoke of this sort of self-denial, and it was in a majority of cases known but to a few persons incidentally connected with the researches in question.

If he guided the activity of others as one would use impersonal agencies in the pursuance of a definite end, he was not less exacting with himself. He not only offered freely to others, sometimes constructive rivals, the raw material of research which he controlled, but in many cases he put in the hands of those

whom he thought worthy his own more or less elaborated manuscripts, to use in their investigations, thus waiving his own priority in the field. His insistence on giving full credit to collaborators of every degree, both in publications and in records, labels and reports, was proverbial. To the tyro treading with uncertain step the entrance ways of science he was ever cordial; always a friend, guide and helper. While Professor Henry lived, the affectionate loyalty of Baird to his venerable chief was an inspiration to those about him.

That this faithful cooperation would not have been a matter of course with most men, however honest in purpose and devoted to science, will be more evident when it is understood that, notwithstanding the well-known views of Professor Henry, enforced by him on every possible occasion, a great museum actually did grow up on their hands, the inevitable result of the scientific activity promoted by Professor Baird. This museum, only after years of effort, and but shortly before Professor Henry's death, came to take its present semi-independent position, such as he would originally have assigned to it. Until this was consummated, Professor Henry's anxieties were very great. When, by Professor Baird's persistent effort, quiet tact and unremitting labor, a distinct organization was finally effected for the museum, it was felt by Professor Henry as the greatest comfort of his declining years. The possibilities of antagonism in such a situation are readily perceptible, and nothing could testify more clearly to nobility of character in both than the fact that such differences never germinated between these faithful servants of science.

When Professor Baird succeeded to the office, it was with a modesty almost amounting to timidity that he spoke of the opportunities and duties of the post. His kindly recognition of his juniors was only changed by the shade of seriousness due to increased responsibility. Only those who were engaged with him can realize what an amount and variety of labor he willingly undertook. During the period of Pacific railroad explorations and the activity of the Hudson Bay Company's people, fired by the enthusiasm of Kennicott during his sojourn in the north, collections and correspondence poured in upon Professor Baird in extraordinary quantity. Not alone was the shedding of its horns by the antelope on the western plains, or the nesting of the canvas-back among Alaskan marshes, the theme of eager letter-writing. The professor and the ladies of his household might often have been seen among the shops seeking novels for the army officer at some isolated post, a necktie for a northern voyager, or the dress goods for a wedding to come off on the banks of the Mackenzie during the crisp Arctic September. It may be imagined that in his home life Professor Baird was altogether lovable, and we can not help saying that not the least of the benefits conferred upon American science was embodied in the influence which extended from that home upon a host of boyish students gathered from year to year under the brown towers of the Smithsonian Institution, slender as to their resources, half Bohemian as to their living, let loose with little restraint in that great disjointed village, the Washington of fifty years ago.

We have dwelt on this occasion not on Professor Baird's scientific researches, his administrative successes, his creation of organized scientific agencies, like the Fish Commission and the present National Museum, nor on the fame and honors which came to him from far and near. We have left these things, which are evident and accessible, to others, and speak here of our impressions of the genius and traits of character which moulded his life and made it truly great. The latter are embalmed in the consciousness of his contemporaries, now so few; and are chiefly unrecorded, while the former may be found in reports and statistics. Two things his experience may be said to have lacked: he never had a personal controversy, nor, so far as we have ever heard or had reason to suspect, an avowed enemy.

WILLIAM H. DALL
SMITHSONIAN INSTITUTION

THE FOUR HUNDRED AND FIFTIETH ANNIVERSARY OF THE BIRTH OF COPERNICUS

NICOLAUS COPERNICUS, philosopher, philanthropist, financial expert and churchman, was born at Thorn, Poland, February 19, 1473. Under the patronage of his uncle, a bishop, he

received the most thorough education of the period, studying mathematics three years at the University of Cracow, canon law and astronomy under Novara at Bologna, lecturing himself in Rome in the year 1500, taking up medical studies at Padua for four years, 1501-1505, and also receiving the degree of doctor in canon law at Ferrara May 31, 1503. He was his uncle's private physician until the death of the latter in 1512, received the post of Canon of Frauenberg, and exerted himself for many years as physician to the poor.

Copernicus laid the main lines of his famous theory of celestial orbits about the year 1513, but published nothing for many years, though endeavoring to test his views with the scanty instruments at his command. His great treatise, "De revolutionibus orbium cœlestium," was finished in 1530 but not published until 1543. It, however, had attracted so much attention while yet in manuscript that lectures were given upon it in Rome much earlier, and the theory received the general approval of the Pope and hierarchy. The first copy of the great work reached Copernicus on his deathbed in 1543, but he was already so low that he probably never appreciated that the book was marred by a preface by Osiander in which he attempted to disarm prejudice by insisting on the purely speculative character of the work.

Copernicus also published a large work on monetary reform.

The Ptolemaic theory which was then in vogue regarded the earth as stationary and accounted for the apparent motions of the planets by a complex system of epicycles. Copernicus, following the suggestion of Professor Novara at Bologna, adopted the view that the sun is the stationary center of the solar system and that the stars are also stationary. He failed to introduce the hypothesis of elliptical orbits for the great planets, including the earth, so that he had still to retain a number of epicycles of Ptolemy.

If, as Copernicus urged, the earth revolves about the sun, the stars ought to show parallactic evidences of this motion just as a forest of trees indicates by the apparent march of the nearer stems with the respect to the farther ones the motion of the observer. The absence of any sensible stellar parallax was for three hundred years the difficulty in the way of Copernicus' theory. Furthermore, to many of the schoolmen the idea of a mobile earth seemed blasphemous.

The defects of Copernicus' theory began to be removed by the careful observations of Tycho Brahe at the observatory at Cassel, erected for him by the Landgrave of Hesse-Cassel. Kepler, the follower of Tycho Brahe, making use of these excellent observations, was able to discover his three famous laws: (1) That planets travel in ellipses with the sun in one focus. (2) That equal areas are described by the radii vectores in equal times. (3) That the squares of the periods of revolution are proportional to the cubes of the mean distances.

Sir Isaac Newton put the capstone on this edifice by his mathematical proof that these three laws of Kepler are all consequences of the hypothesis of an attracting force of gravitation varying proportionately to the product of the masses, and inversely to the squares of the distances separating them.

The final difficulty of the Copernican theory was removed in 1838 by the nearly simultaneous measurement of Bessel and Henderson of the parallaxes of the stars 61 Cygni and of α Centauri.

At this time of the four hundred and fiftieth anniversary of the birth of Copernicus, it is well to reflect upon the momentous consequences of the release of the human mind from the bonds of blind obedience to preconceived notions, partly religious and partly superstitious, which had made the speculations of the schoolmen so fruitless and had made life and property so insecure from the inquisition of those who felt themselves responsible for the destruction of heresy. Copernicus has left us a model of the earnest, kindly, modest student of science, content to test and verify before publication, but withal concerning himself with the profoundest problems of his time.

The Smithsonian Institution will hold an informal meeting at 4 o'clock, February 19, for its employees and others who may care to attend, at which a brief address will be made by the assistant secretary, Dr. Abbot, on Copernicus and his astronomical theory. The institution regards it as very appropriate that similar meetings should be held at that time at other seats of learning.

C. G. ABBOT

SMITHSONIAN INSTITUTION

SCIENTIFIC EVENTS

EDWARD JENNER[1]

IT is a hundred years since the remains of Edward Jenner were laid to rest in a vault in the chancel of Berkeley Church. He died on January 26, 1823, and was buried on February 3. He had been born in 1749 in the vicarage of Berkeley, and spent a large part of his professional life in his native village as a general practitioner—one of the most illustrious who has ever adorned the ranks of medicine. His great teacher and friend, John Hunter, wanted him to enter on a different career; but Jenner was a born naturalist, fond of a country life, so that even when, in the interests of vaccination, he was persuaded to take a house in London, he quickly repented, and later on returned to Berkeley.

The oft-told story of his great conception of preventing small-pox by means of cow-pox is classical in its simplicity and brevity. In his master's surgery at Sodbury he heard a countrywoman remark that she could not take small-pox because she had already had cow-pox. The little incident remained in the mind of the busy village doctor for many years, to be mused over, discussed with friends lay and medical, set aside and returned to with a curious mixture of perseverance and dilatoriness which was no doubt in his mind when he remarked in his *Inquiry* that people may not be aware "how often men engaged in professional pursuits are liable to interruptions which disappoint them almost at the instant of their being accomplished. Ultimately, however, in 1796, he put the matter to the touch—he inoculated with cow-pox, tested the effect by inoculation with small-pox, and found that immunity had been achieved. The rest of his life was devoted mainly to the promotion of vaccination. . . .

The centenary of Jenner's death follows close on that of Pasteur's birth. Their lives overlapped by a month, Pasteur having been born thirty days before Jenner died. Their life's labors were closely related. Apart from variolation with its serious disadvantages, vaccination was the first example of the operation of the principle of individual immunization. For the greater part of a century it remained an oasis in a desert, and for long there seemed no prospect of its further application. Now, however, since Pasteur brought into existence the science of bacteriology, the sphere of immunization by different methods has been wonderfully extended, and the armamentarium of preventive medicine correspondingly strengthened. In a remarkable passage in one of his books Sir John Simon wrote that "if departed great benefactors of our race could now and then look down on the harvest fields where mankind age after age is gladdened by the fruits of their labor, they would in general find themselves less remembered than perhaps their terrestrial ambitions had desired"; but, he adds, "let the noble compensation be noted that often the thoroughness of a reformer's victory is that which most makes silence of the reformer's fame. For how can men be adequately thankful for redemptions, when they have no present easy standard, no contrast between yesterday and to-day by which to measure the greatness of them?" That question applies specially to the case of Jenner, but neither Jenner nor Pasteur can ever be forgotten. It was, if we recollect aright, in an address at the centenary of the death of Robert Burns that Lord Rosebery, speculating about the duration of personal fame, prophesied that if there were every hundred years a roll call of the famous departed, the "Adsum" of Burns would sound clear and strong all down the coming time. In the much more prosaic sphere of preventive medicine and the benefactions of science, so it will be with Edward Jenner and Louis Pasteur.

[1] *The British Medical Journal.*

THE LONDON ZOOLOGICAL GARDENS[1]

IN consequence of the retirement on pension of Mr. R. I. Pocock, F.R.S., who attains the age of sixty in March after having been superintendent of the Zoological Gardens and curator of mammals since 1904, the council has rearranged the staff at the gardens. Dr. G. M. Vevers, at present a Beit Research Fellow and on the staff of the London School of Tropical Medicine, has been appointed superintendent, and, under the direction of the secretary, will be the principal officer there. Mr. D. Seth Smith, at present curator of birds and inspector of works, has been promoted to be curator of

[1] From the *London Times.*

mammals and birds with a residence in the gardens. Mr. E. G. Boulenger retains his curatorship of the reptiles, but will also be in charge of the new aquarium. Miss Cheesman remains curator of insects, Dr. Sonntag, anatomist, and Dr. Lucas, pathologist, are also to be in charge of the sanatorium (which is being re-equipped), in consultation with Professor Wooldridge, honorary veterinary surgeon to the society, and the superintendent and curators. A panel of experts under the honorary direction of Professor Leiper, of the London School of Tropical Medicine, has undertaken the collection and examination of the parasites. Dr. R. W. A. Salmons, M.D., F.Z.S., honorary radiologist at University College Hospital, has been appointed honorary radiologist to the society.

Mr. R. I. Pocock, the retiring superintendent, was formerly on the staff of the British Museum (Natural History), an appointment which he resigned in 1904 when he went to the gardens. His chief zoological work until 1904 was on arachnids and myriapods, on which difficult groups he was a recognized authority. Since 1904 he has devoted himself chiefly to mammals, and he has published a large number of memoirs in technical scientific journals on the classification of many groups and especially on the bearing of external characters on the systematic position of mammals. For many years he has been a regular contributor to the *Field*, on the staff of which he remains, and he is the author of a number of papers on natural history. He is a vice-president of the Linnean Society and was elected to the Royal Society in 1911. His knowledge of the species and varieties of mammals is very great, and he was able to identify any mammal brought to the gardens, however rare, almost at a glance and to say whether it was new to the collection.

Dr. Vevers is thirty-three years old. When the war broke out he was in his fifth year as a medical student at St. Thomas's Hospital, but joined the army at once. In 1915 he was sent back from France with other former medical students in their fourth and fifth years and, after qualifying, was given a commission in the R. A. M. C., and served in France until the middle of 1918, when he was sent home for duty in this country. On being demobilized in 1919 he engaged in private practice for a few months and was then appointed to the London School of Tropical Research. Soon afterwards he gained a Beit Memorial Research Fellowship for work in parasitology. He was honorary parasitologist to the society for two years and already has a good knowledge of the gardens. In 1921 he was sent on a scientific mission to British Guiana, where he was able to make some collecting expeditions into the bush. He has undertaken to devote his scientific work in future to the problems relating to animals, including their psychology, which can be better studied in a collection of living animals than in a museum or laboratory.

LIST OF SCIENTIFIC PERIODICALS

AT a meeting of the Conjoint Board of Scientific Societies held at the Royal Society on January 24 a definite constitution was given to a scheme to prepare and issue a list of all scientific periodicals containing the results of original research, with an indication of the chief libraries in Great Britain where they may be consulted.

As has already been reported in SCIENCE, an influential committee representing different branches of science has been arranging for the preparation and publication of a complete list. The trustees of the British Museum, recognizing the importance of the work to scientific research and bibliography, consented to allow the preparation of the list to be undertaken by the staff of the keeper of printed books. Material has been sent in by many scientific societies and libraries, and there is good hope that the list will be published before the end of the year. As the result of a preliminary circular, between three and four hundred copies have already been subscribed for at £2 each. The Carnegie United Kingdom Trust have guaranteed the cost of publication up to £1,000 on condition that libraries at a larger number of centers in Great Britain than was originally intended should be included. Sir Robert Hadfield and Mr. Robert Mond have each given a further guarantee of £250.

The Conjoint Board, after having heard the satisfactory progress already made, agreed to vest the World List in three permanent trustees—Sir Arthur Schuster, F.R.S., Mr. Robert Mond and Dr. Chalmers Mitchell, F.R.S.—the trustees to have complete financial control.

but to be advised on the general conduct of the scheme by the existing committee.

CORNELL UNIVERSITY SUMMER SCHOOL OF BIOLOGY

A SUMMER school of biology will be established at Cornell University this year. It will be conducted under the joint auspices of the university's regular summer session and the New York State College of Agriculture. Intensive courses of study designed particularly for teachers and graduate students will be given during the six weeks' summer session from July 7 to August 17, and facilities will be provided for research throughout the summer.

This will be a fresh-water school of biology, as distinguished from several coastwise summer schools in which marine forms of plant and animal life are necessarily the principal objects of study and demonstration. Teachers and investigators in the interior states have felt the need of a summer school where the materials for the study of biology are the same as those which they find available for use in their own class rooms and laboratories. The neighborhood of Cornell University is said to have an extraordinary wealth of such materials in both plants and animals. Within easy reach of the laboratories are fresh-water lakes and marshes, salt springs, marl springs, marl bogs, peat bogs, extensive and deep ravines with numerous waterfalls and upland woods and fields overlying either sandy or heavy soils. Some of these soils are impregnated with lime and some are not. Within a radius of two miles of the Cornell campus there is a variation of more than a thousand feet in altitude, so that the plants and animals in this small area belong to several different life zones.

Biology has been studied intensively at Cornell ever since the time of Louis Agassiz, who was a teacher there fifty-five years ago. One result of this sustained interest has been to assemble there a wealth of laboratory material, including some unique collections of plant and animal specimens, and a complete working library, all of which will be available for those students who are prepared to use them.

As far as possible the staff of the school will be composed of professors who are members of the regular faculty of the university. The teachers will include Professors O. F. Curtis, A. J. Eames, H. M. Fitzpatrick, A. C. Fraser, W. C. Muenscher, H. H. Whetzel and Karl M. Wiegand in botany, plant pathology and plant breeding; Professors J. C. Bradley, O. A. Johannsen and Robert Matheson in entomology; Dr. B. F. Kingsbury in animal histology and embryology; Dr. W. A. Hagan in pathology and bacteriology, and Professors Hugh D. Reed and Albert H. Wright in zoology.

THE MEDALS OF THE AMERICAN GEOGRAPHICAL SOCIETY

THE American Geographical Society announces the award of the Charles P. Daly Medal for 1922 to two recipients: Major General Adolphus Washington Greely and Ernest de Koven Leffingwell. The Cullum Geographical Medal for 1922 has been awarded to Edward A. Reeves, map curator of the Royal Geographical Society, London, and director of the School of Surveying. The inscriptions upon the medals themselves briefly indicate the reasons for the award in each case. They are as follows:

ADOLPHUS WASHINGTON GREELY
1922

He commanded an Arctic expedition the results of which are among the imperishable records of polar discovery; and he subsequently rendered distinguished public service as chief of the United States Signal Corps.

ERNEST DE K. LEFFINGWELL
1922

For producing the first accurate chart of a part of the Arctic coast of Alaska and for sustained and original investigations in Arctic physiography.

EDWARD A. REEVES
1922

In honor of his substantial achievements in geographical surveying. By devising and improving instruments and methods he created new standards in the field of scientific exploration.

SCIENTIFIC NOTES AND NEWS

DR. EDWARD E. BARNARD, professor of astronomy in the University of Chicago and astronomer of the Yerkes Observatory, died on February 7 at his home at Williams Bay, aged sixty-five years.

BERNHARD EDUARD FERNOW, first chief forester of the United States, died at Toronto on February 6, aged seventy-three years. In 1898 he became dean of the School of Forestry at Cornell University. After the closing of the school by the legislature in 1907, he became dean of the faculty of forestry at the University of Toronto, retiring as professor emeritus in 1919.

WILHELM KONRAD ROENTGEN, professor of physics in the University of Munich, who obtained in 1895 a world-wide reputation by the discovery of the X-rays, has died in Munich at the age of seventy-seven years.

DR. JOHANNES ORTH, the distinguished pathologist, and successor of Virchow at the Berlin Pathological Institute, died on February 13 within a few hours of his seventy-sixth birthday.

PROFESSOR A. A. MICHELSON, of the University of Chicago, was awarded the gold medal of the Royal Astronomical Society for the "application of the interferometer to astronomical measurements," at the annual meeting of the society in Burlington House, London. Professor Michelson, being unable to attend personally, was represented by Post Wheeler, chancellor of the American embassy.

DR. J. PAUL GOODE, of the University of Chicago, was presented with the Helen Culver gold medal at a meeting of the Geographic Society of Chicago on January 26.

PROFESSOR DOUGLAS W. JOHNSON, of Columbia University, has been elected a foreign member of the Swedish Society for Anthropology and Geography.

PHYSICIANS, graduates of Northwestern University and students under Dr. Winfield Scott Hall, professor of physiology at Northwestern University School of Medicine, Chicago, gave a dinner in his honor at the Plaza Hotel, Danville, on January 17.

DR. T. WAYLAND VAUGHAN has been elected president of the Washington Academy of Sciences.

HENRY SOLON GRAVES, dean of the forestry school of Yale University, was elected president of the American Forestry Association at its meeting in Boston.

DR. A. S. HITCHCOCK, of the Bureau of Plant Industry, has been elected president of the Biological Society of Washington for 1923.

THE following officers of the State College, Pennsylvania, Branch of the American Association for the Advancement of Science have been elected for 1923: *Chairman,* C. R. Orton; *vice-chairman,* R. D. Anthony; *treasurer,* J. E. DeCamp; on the *executive committee,* Miss Edith P. Chace and D. C. McFarland. The tenure of office of secretary is for four years and the present term does not expire until 1924. The other offices are filled each year.

PROFESSOR W. P. WYNNE has been nominated to fill the office of president of the Chemical Society, London, which will be vacated by Sir James Walker.

DR. W. H. ECCLES, professor of electrical engineering at the City and Guilds of London Technical School, and vice-chairman of the Wireless Telegraphy Commission, who succeeds Admiral of the Fleet Sir Henry Jackson as president of the Radio Society of Great Britain, delivered his presidential address to the society at the Institution of Electrical Engineers on January 24.

PROFESSOR FILIBERT ROTH, head of the department of forestry of the University of Michigan, whose resignation from the faculty has been accepted with regret by the regents, will remain with the university until the close of the present academic year.

PROFESSOR WILLIAM NIKOLAI BOLDYREFF has taken a position at the Battle Creek Sanitarium, where he will conduct research along lines similar to those followed by him with Pawlow in Petrograd. Professor Boldyreff was an assistant to Pawlow from 1902 to 1912. From 1912 to 1917 he was professor of pharmacology in Kazan, Russia.

DR. J. C. MCLENNAN, professor of physics at the University of Toronto, has been granted a leave of absence for the remainder of the school year. He will visit important laboratories of Great Britain, France and Holland, returning in September in time for the meeting of the British Association for the Advancement of Science, which meets this year at the University of Toronto.

DR. WILLIAM WALTER CORT, associate pro-

fessor of helminthology in the Johns Hopkins School of Hygiene and Public Health, has been appointed exchange professor in parasitology in the Peking Union Medical College for the academic year beginning October, 1923. Professor Cort will also study hookworm disease in South China. Dr. Ernest C. Faust, associate professor of parasitology at the Union Medical College, will exchange professorships with Dr. Cort.

DR. BÉLA SCHICK, professor of pediatrics at the University of Vienna, gave the Cutter lecture on preventive medicine at Harvard University on February 8. His subject was "The prevention and control of diphtheria."

THE seventh Harvey Society lecture to be given at the New York Academy of Medicine on Saturday evening, February 24, 1923, will be delivered by Dr. Leon Asher, professor of physiology in the University of Berne. His subject will be "The building up of the organism by chemical and nervous coordination and regulation." The lecture by Dr. E. V. Cowdry, of the Rockefeller Institute for Medical Research, on "The significance of the internal reticular apparatus of golgi in cellular physiology," has been postponed until Saturday evening, March 10.

PROFESSOR SOMMERFELD will give the following course of lectures at the Bureau of Standards from March 2 to 9: "Introduction to quantum theory and its place in modern physics," March 2; "Quantum theory of spectroscopy, Balmer spectrum of H, etc.," March 3; "Atomic structure of the chemical elements," March 5; "Wave theory and quantum theory," March 6; "The significance of quantum numbers, azimuthal, radial, equatorial, inner, etc.," March 7; "Zeeman effect, theory of magneton," March 8; "Line structure in complicated spectra," March 9.

PROFESSOR R. A. EMERSON, head of the department of plant breeding at Cornell University, lectured before the Ohio chapter of the Sigma Xi Society on January 31 on "The mechanism of organic heredity."

DR. EVARTS A. GRAHAM, professor of surgery in the Washington University School of Medicine, has accepted an invitation from the California Academy of Medicine to speak on the "New phases of thoracic surgery." He held a clinic at the Leland Stanford University on February 9 on thoracic surgery, and a clinic on gall bladder surgery at the University of California on February 10.

DR. E. F. PHILLIPS, of the U. S. Bureau of Entomology, gave an address on "Research in bee-keeping with practical applications," before a joint meeting of the Purdue Chapter of Sigma Xi and the Purdue Biological Society at Lafayette on February 1.

DR. E. H. STARLING will deliver the Harveian lecture of the Royal College of Physicians, Dr. J. H. Abram, of Liverpool, the Bradshaw lecture, and Lieutenant Colonel William Glen Liston, C.I.E., the Milroy lectures in 1924. The Milroy lectures for this year will be delivered by Dr. W. G. Savage, on "Canned foods in relation to health," on February 22 and 27 and March 1; the Goulstonian lectures, by Dr. Geoffrey Evans, on "The nature of arteriosclerosis," on March 6, 8 and 13, and the Lumleian lectures, by Dr. Arthur J. Hall, on March 15, 20 and 22, on "Encephalitis lethargica."

A COMMITTEE has been formed to establish a memorial to Benjamin Harrison, the village geologist and prehistoric archeologist of Ightham, Kent, England, who died in 1921. The first meeting of the committee was held at the Royal Anthropological Institute in November, 1922, under the presidency of Lord Avebury. Donations will be received by the treasurer, Mr. de Barri Crawshay, Rosefield, Sevenoaks (Kent).

THE Wellcome Historical Medical Museum, London, has arranged a special exhibition of personal relics, pictures, engravings, drawings, documents, manuscripts and letters relating to the discovery of vaccination, in connection with the commemoration, on January 26, of the centenary of the death of Dr. Edward Jenner. The exhibition will be open for some months.

THE centennial of the birth of the surgeon, Friedrich von Esmarch, who died at Kiel in 1908, occurred on January 9, 1923.

ROBERT MORAN, Puget Sound shipbuilder, has given to the University of Washington a $12,000 towing boat, the *Rosario*, to be used at the university's Puget Sound biological station, at Friday Harbor, Washington, in dredg-

ing for deep-sea biological specimens. This is the third offer which Mr. Moran has made to the university. In donating a park at Mount Constitution to the state of Washington, he expressly reserved the right of the university to make use of this tract for scientific and educational purposes. Later when the university was seeking to find a larger and more effective property for its biological station, he offered the regents, as a gift, the valuable property known as Obstruction Island. Meanwhile, the government had given to the university the Point Caution military reservation of four hundred and eighty-five acres, which was more favorable from a scientific standpoint.

DR. LEE DE FOREST, the inventor of the "audion" and other improvements in radio apparatus, has established a fund for the purchase for Yale University of a library devoted to radio matters, which will be of service to those engaged in study and research in this field. He has also established a fund to provide for a course of twelve lectures to be given each year for the benefit of advanced students and members of the staff. It will be possible, with the aid of this fund, to invite to Yale University each year a number of leading experts to supplement the work of the regular courses offered by the university. For the present year, beginning in February, the lectures will be given by the following men: George A. Campbell, American Telephone and Telegraph Company; Lloyd Espenscheid, American Telephone and Telegraph Company; Commander S. C. Hooper, United States Navy; Dr. Albert W. Hull, General Electric Company; Professor John Morecroft, Columbia University, and L. E. Whittemore, Bureau of Standards. Dr. de Forest will speak on "Wireless" at the eighth annual meeting of the Yale Engineering Association, which will be held at the New York Yale Club on February 1. Apparatus will be installed and a demonstration given.

THE New York State Museum is again offering to the public a course of lectures on subjects of general and public interest. They are given in the rooms of the museum in the State Education Building on Friday afternoons at 4 o'clock. The schedule of lectures is as follows: January 12, "A naturalist in the Adirondacks," by Homer D. House, state botanist; January 19, "Indian medicine and medicine men," by Arthur C. Parker, state archeologist; January 26, "Origin and evolution of the insects," by Ephraim P. Felt, state entomologist; February 2, "Are we still living in the glacial period?" by John H. Clarke, state geologist; February 9, "Where are we from?" by John M. Clarke; February 16, "What the salamanders do," by Sherman C. Bishop, state zoologist; February 23, "The story of petroleum in New York," by C. A. Hartnagel, assistant state geologist; March 2, "Insects and wireless," by Ephraim P. Felt; March 9, "The great Devonian forest," by Winifred Goldring, state paleobotanist; March 16, "Mastodons and mammoths," by Sherman C. Bishop; March 23, "The background of New York history," by John M. Clarke; March 30, "Wild flowers and their protection," by Homer D. House.

ONE HUNDRED THOUSAND DOLLARS of the $200,000 legacy left to Harvard by the late Hiram F. Mills, of Quincy, to establish the Elizabeth Worcester Mills fund with its income devoted to the investigation of the origin and cure of cancer, has been received. This income will aid the work of the Harvard Cancer Commission which is carrying on extensive research in the new John Collins Warren Laboratory adjoining the Huntington Memorial Hospital. It is expected that the bequest will make possible a much more detailed investigation of the constitutional effects of radium and especially of the high-powered X-ray machine designed by Professor William Duane and installed in the new laboratory for the treatment of cancer cases.

DR. G. J. ESSELEN, JR., chairman, cellulose division, American Chemical Society, writes that Dr. C. J. West, chairman of the committee on bibliographies of the Technical Association of the Pulp and Paper Industry, has kindly offered to act for the Cellulose Division of the American Chemical Society as a receiving center for bibliographies relating to any branch of cellulose chemistry. It is hoped that all of those having such bibliographies will send a copy to Dr. West, the National Research Council, 1701 Massachusetts Avenue, N. W., Washington, D. C. Dr. West has kindly offered to assemble all material received and

make it available to any one interested. It is hoped that a large amount of duplication of effort can be avoided in this way.

UNIVERSITY AND EDUCATIONAL NOTES

THE will of the late John McMullen, of Norwalk, Conn., and New York, was upheld by a jury in the Superior Court on February 7. A compromise was reached, but no details were given out. Under the will the bulk of the $2,000,000 estate goes to Cornell University.

MR. DAN RADCLIFFE, the shipowner, of Cardiff, has promised to give £50,000 in 3½ per cents. for the benefit of the University of Wales in honor of the Prince of Wales.

DR. THOMAS STOCKHAM BAKER, formerly professor of German in the Johns Hopkins University and director of the Jacob Tome Institute, has been elected president of the Carnegie Institute of Technology, where he has been since 1919 secretary of the institute and acting president since the resignation a year ago of Dr. A. A. Hamerschlag.

DR. OTTO M. SMITH, formerly in charge of research for the Roseville Chemical Company, Roseville, Indiana, has been appointed assistant professor in quantitative chemistry at Iowa State College.

PROFESSOR F. TRENDELENBUEG, of Tübingen, has refused a call to the University of Berlin to serve as the successor of Rubner for the chair of physiology. A call has been sent to Dr. Franz Hofmann, of Bonn.

PROFESSOR H. POLL, of the University of Berlin, has been appointed professor of general biology and the theory of heredity.

DR. POTTEVAN, senator, has been elected professor of general hygiene in its relations to industry in the Paris Conservatoire National des Arts et Métiers.

DISCUSSION AND CORRESPONDENCE

REACTION TIME AND FATIGUE

THE personal equation in star transits is due to the coordination of eye, hand and brain of the observer. Its absolute amount is difficult to determine, as artificial transits must always lack some features of the usual observing conditions. Fortunately it does not affect most of our right ascension results, since they are derived from the differences of transits, in which the effect is eliminated, if it is constant. In longitude campaigns, also, the difference of personal equations can be eliminated by exchanging stations.

We can not determine absolute clock corrections, nor absolute clock rates without taking account of personal equation and its constancy. For the mean daily rate of a clock, derived from successive observations of the same stars, the equation eliminates, if it is constant. For hourly rates, derived from successive clock corrections during a night, the question of variability of personal equation needs consideration. Variation might be produced by fatigue or other physical conditions.

There are traditional stories in astronomical practice of observers who indulged in the excessive use of strong stimulants, such as coffee, in excessive smoking and, possibly, taking into account the origin of these stories, in *Pilsener* for the contrary reflex, and then proceeded to determine the effects upon observations. Large accidental variations would be anticipated, rather than systematic changes, with such abnormal deviations from the habits of rational observing.

In the series of observations recently completed here for the purpose of testing a possible diurnal periodic term in clock performance, the test of change in personal equation emerges as a by-product. The test is a delicate one, and it is only by assembling a relatively large mass of material that a reliable conclusion can be reached.

Six hours of continuous observing have been included on each of twenty-four nights during a complete year, nearly two thousand transits in all. For the usual night of about four hours' interval no sensible amount of physical or mental fatigue is commonly experienced. Perhaps it is the consequence of more than forty years of observing that renders an observer sensitive to real fatigue at the close of six hours of work. Ordinarily it would not be considered wise to continue work when the precision of the results might be affected by physical conditions, but the requirements of this special problem made it advisable to use these long periods.

In the closing error of a cycle of observed clock rates, where each pair of successive hours of right ascension has been employed, with invariably the same stars in each hour, there are four conditions to consider, as influencing the results.

The errors of the adopted right ascensions enter every computed hourly rate, but these errors are completely eliminated in summing up the cycle.

Progressive change in instrumental corrections would produce progressive changes in computed clock rates, if undetected, and the performance of the meridian instrument has consequently received careful and rigorous treatment in this special series.

The difference between clock corrections observed at sunset and sunrise may be due to special conditions affecting the observed results at these two epochs of the day, or to a diurnal variation in the clock rate.

Progressive change in personal equation during the night would produce a computed change of observed clock rates.

The closing error of this series will be assumed to be due to either one or both of the last two conditions enumerated.

The summation of the observed clock rates gives the following means for successive pairs of hours from 9 P. M. to 3 A. M. The means are the excesses of observed hourly rates over the average daily rates of the clock at the corresponding epochs.

	s.
First two hours, excess	—0.002
Second two hours, excess	—0.003
Third two hours, excess	+0.005
Fourth two hours, excess	+0.005
Fifth two hours, excess	—0.000
Mean	+0.001
Average	±0.003

The probable error of observation for a rate from two successive hours, as summed up, is ±0.ˢ002. The deviations from the mean of all are evidently fortuitous and there is no real progressive change such as would be due to the effect of fatigue or to periodic variation of the clock rate, unless these two effects balance each other.

The constancy of the reaction time, assuming uniform performance of the clock, should interest psychologists and physiologists, and the measure of its variations within errors of less than one one-hundredth of a second can be confirmed by other observers.

R. H. TUCKER

LICK OBSERVATORY

PHYSIOLOGY OF STOMATA OF RUMEX PATIENTIA

THE behavior of the stomata of *Rumex patientia* has been studied for the past two years and, although the work has not been completed, the data at hand are sufficient to warrant the following conclusions:

1. The stomata close completely at night and check water loss from the intercellular spaces of the leaf.

2. When open the stomata modify the rate of water loss from the intercellular spaces of the leaf in proportion to changes in their perimeters, not to changes in their areas.

3. Light is the most important environmental factor, while acidity and the amount of water in the guard cells are the two internal conditions directly concerned with stomatal movements.

4. The guard cells contain green plastids which are structurally, physiologically and genetically different from the chloroplasts of the mesophyll.

5. The starch-sugar change in the guard cells is an equilibrium reaction and the point of equilibrium is shifted by changes in acidity. The guard cells change in acidity more readily than the mesophyll cells because their buffer content is low.

6. The series of changes which result in the opening of the stomata is as follows:

(*a*) In the morning the light changes the acidity of the guard cells.

(*b*) This change in acidity makes conditions more favorable for the hydrolytic action of diastase.

(*c*) The diastase in the guard cells changes the starch to sugar.

(*d*) The formation of sugar results in an increase in the osmotic pressure of the guard cells.

(*e*) Water enters the guard cells from the epidermal cells which do not change in pressure and causes them to swell.

(*f*) The swelling of the guard cells causes them to open because the thickened cell wall

around the pore stretches less than the thinner parts of the cell wall.

This series of changes does not take place if the leaves are wilted. If wilting occurs after the guard cells are open the point of equilibrium is shifted so that the sugar changes to starch and the guard cells close. If the leaves remain turgid the guard cells remain open until darkness and close by a reversal of this series of changes. These changes can be made to go in either direction by experimentally changing the acidity of the guard cells.

J. D. SAYRE

DEPARTMENT OF BOTANY,
OHIO STATE UNIVERSITY

A BOTANICAL SPELLING MATCH

"CAN one imagine a botanical or an entomological spelling match?" "Could 'aster' or 'grasshopper' be drawn in recognizable detail by the contestants?" These are two of the questions asked by Dr. C. E. Waters in SCIENCE for November 24.

The writer can not answer for entomology but he can for systematic botany. Formulæ may be used to express the structure of flowers. For example, the flower formula of the Boraginaceæ can be written $Ca^{(5)}\ \overline{Co^{(5)}}\ P^{(4)}$, of the Liliaceæ $Ca^3\ Co^3\ S^6\ P^{(3)}$. In this way formulæ may be written for families, genera and species. The flower formula expresses concisely the following features: number of parts in the flower, kinds of parts, arrangement of parts, something of the shape of the flower and the position of the flower in evolution. On hearing or reading such a formula the structure and shape, as well as the taxonomic position, of the flower are immediately brought to mind. Surely it would not be difficult to imagine a spelling match in a class in systematic botany!

HERBERT C. HANSON

DEPARTMENT OF BIOLOGY,
UNIVERSITY OF ARIZONA

SCIENTIFIC BOOKS

A GUIDE BOOK OF THE GEOLOGICAL SURVEY

THE fifth volume of the series of guide books of the western United States which our national geological survey has been producing in the last seven years is as attractive as its predecessors.

It deals with that portion of Colorado and Utah which is served by the Denver and Rio Grande Western Railway, a region visited by more tourists than any other portion of the country west of the Mississippi. To them this book would be a boon if it could be brought to their notice. Being an official publication bound in a grey paper cover it is not apt to be as widely known as it would be were it published by an enterprising publishing house, bound in bright red cover, placed in all the book stores, and mentioned in many magazines and circulars. But it is worthy of wide publicity because of its excellence. Campbell has beaten Baedeker at his own game. The book is charmingly written, beautifully illustrated and furnished with excellent maps.

The main part of the text presents in clear manner the succession of events which have resulted in the present Colorado and Utah. It does not go back just a few months or years, but begins far enough back to include the whole history of the region from earliest archæan times till 1922 A. D.

The foot notes in fine print contain the side lights on the main circuit. They deal with economic statistics, histories of individuals, explanations, definitions and illustrations of the main theme and are hardly less interesting or important than the main theme.

The central topic—the present constitution, structure and topography of the country and the forces which have produced them—is presented in a clear manner as entertaining as the talk of a clever man at a club. University students in that part of the country will no doubt use the volume as a text book since it may be obtained of the United States superintendent of documents for one fourth the price necessarily charged for the average geology, and since it is so practical and interesting. The average geological text book has the disadvantage of jerking the mind from one part of the world to the other for illustrations. This book illustrates point after point right on the spot. In the regions treated the reader can see nearly every principle of the earth's history strikingly set forth.

To apply geology to a definite locality is an

excellent practice. It tends to take the science out of the realm of theory and place it in that of reality and give it "a local habitation and a name."

Fortunate is the man who in spite of other pressing duties, finds time to read this book through and in this manner adds to the pleasure of former or coming trips in this region.

If further editions are brought out it would be well to name the formations shown in pictures and sections. For example in Plate XXI is Lyons sandstone of the Pennsylvania System seen at the gateway of the Garden of the Gods. In Figure 10, p. 37, why should "N" indicate Morrison, "B" Fox Hill, "T" Pennsylvanian, etc.? Why use one series of signs to indicate another series? Why not write down directly the name of the formation indicated and so all through this and the majority of works on geology? This old custom of using one sign to represent another sign is the geologist's way of whipping the devil around the stump. The direct action plan will help to drive away ignorance in geological matters.

A sketch map of Corona and the Denver and Salt Lake Railroad might well replace one of the two illustrations of Castle Rock (p. 21 and 26).

The present writer may be excused in inquiring why the state museum was not mentioned on p. 6.

Suggestions such as the above are mere incidents. As a whole the book is delightful and valuable and people who discover it will be indeed fortunate.

A. R. CROOK.

STATE MUSEUM,
SPRINGFIELD, ILLINOIS

SUGGESTIONS FOR A WORLD-CODE OF PLANT NOMENCLATURE

THE trend of a recent discussion in *The Journal of Botany* (London, 1921, 153, 289; 1922, 111, 129, 199, 256, 313) suggests that the time is ripe for an attempt to secure world-wide agreement on plant-nomenclature. It has been shown that the divergence between the Type-basis Code and the International Rules leads to dual nomenclature in one out of every nine species of Phanerogams, apart from any differences in generic concept (op. cit. 1922, 129-131). Few will deny that such a state of affairs seriously handicaps the progress of systematic botany, since it necessarily results in much time, which might otherwise have been devoted to taxonomic work, being occupied with questions of nomenclature.

Is it not possible to combine the best features of both codes? An excellent summary of the chief differences between them has been given by Mr. A. S. Hitchcock (op. cit. 1922, 316). These concern (1) the type-concept; (2) the starting-point or points of nomenclature for certain groups of non-vascular plants; (3) nomina conservata; (4) publication of genera; (5) priority of position; (6) validity of homonyms; (7) duplicate binomials; (8) Latin diagnosis.

To deal with the less controversial points first: No. 7 is surely of little moment. Personally, after considering the arguments for and against, I am now in favor of accepting duplicate binomials, on the ground that the advantage of preserving the earliest specific name outweighs all other considerations. Duplicate binomials are less open to objection than many names which are treated as valid under the International Rules. No. 2 is a matter for the cryptogamists concerned: if they can arrive at an agreement, so much the better; but, if not, why should this stand in the way of agreement on other points? As to No. 8, many Internationalists now consider that Art. 36, which made a Latin diagnosis obligatory, should be revoked.

In regard to No. 4, publication of genera, the Rules treat a generic diagnosis (or reference to a former diagnosis of the group) as obligatory: otherwise it would be open to any name-monger to establish an unlimited number of new genera, without the slightest indication of their generic characters, by merely mentioning the names of species included in them. Surely no group should be recognized unless its diagnostic characters have been given. On the other hand, the Code requires that a generic name should be associable with a binomial specific name, this being essential under the type-system. Are not both requirements reasonable? For the complete definition of a genus, both its diagnostic characters and the species included in it should be stated.

There remain for consideration (1), the type-concept; (3) nomina conservata; (5)

priority of position; and (6) validity of homonyms. These questions are closely connected.

As has been pointed out, the type-concept is not contrary to the International Rules. One obstacle to its adoption by Internationalists, however, is the rigid manner in which it has been applied. Provided that wholesale changes in generic nomenclature are avoided by the recognition of "substitute types," as suggested by Mr. Hitchcock, there seems no reason why the type-concept should not be explicitly incorporated in the International Rules.

The chief difficulties are connected with "nomina conservata" and homonyms. It seems certain that "nomina conservata" will retain a place in any International Rules of the future. But the present list admittedly contains some generic names which should not have been included. And the Type-basis Code recognizes that the strict application of the law of priority may cause inconvenience by displacing well-known names, and provides for exceptions through Art. 6. Hence there is no difference of principle involved, and it is merely a question of deciding what names should be included in the list. This task might be entrusted to a joint committee, as suggested by Mr. Hitchcock (op. cit. 1922, 318). Among names which might be deleted from the list are cases of wrong application of generic names such as *Allionia* Linn. emend. Choisy (op. cit. 1922, 314) and those of unimportant genera with few species.

The present provisions of the International Rules in regard to homonyms are admittedly unsatisfactory, as they make the validity of a homonym dependent on the non-validity of the first use of the name, which may be a matter of opinion (op. cit. 1922, 133). Under the Type-basis Code, on the other hand, many well-known generic names are replaced on the ground of their being homonyms, which is equally unsatisfactory. It is therefore suggested (1), that all specific homonyms should be treated as non-valid; (2) that such well-known generic names as are homonyms should in the discretion of the proposed committee be placed on the list of nomina conservata; (3) that all other generic homonyms should be treated as non-valid.

Priority of position is an extreme extension of the principle of priority and might well be abandoned in the interests of general agreement. My suggestions for harmonizing the International Rules and the Type-basis Code may now be summarized as follows:

1. Acceptance of the type-concept, with provision for the recognition of "substitute types."
2. Acceptance of a list of generic "nomina conservata" to be prepared by a joint committee, the present list being taken as a general basis.
3. Treatment of generic homonyms as non-valid, with the exception of such as may be placed on the list of "nomina conservata."
4. Treatment of all specific homonyms as non-valid.
5. Abandonment of priority of position.
6. Abandonment of an obligatory Latin diagnosis of new groups; recommendation, however, that a Latin diagnosis should be supplied especially in cases where descriptions are published in languages which do not employ Roman characters.
7. Treatment of generic names as non-valid unless they are accompanied by a generic description or a reference to a former description (generic or sectional).
8. Treatment of generic names as non-valid unless they are associable with a simultaneously or previously published binomial specific name. Provision, however, to be made for the typification of important genera which would otherwise be invalidated under this rule.
9. Acceptance of duplicate binomials.

It should be mentioned that the above suggestions embody only my personal views, and are offered as a possible basis on which the Type-basis Code and International Rules might be harmonized. They differ in some respects from suggestions previously made by me (op. cit. 1921, 153; 1922, 129, 313), which were put forward entirely on their own merits, as a logical development of the present International Rules.

The acceptance of any basis of agreement will call for sacrifices on both sides. Is it too much to hope that they will be cheerfully offered in the common cause of the advancement of Systematic Botany?

T. A. SPRAGUE

ROYAL BOTANIC GARDENS,
KEW, ENGLAND

REMARKS ON MR. SPRAGUE'S SUGGESTION

THE International Rules of Botanical Nomenclature are familiar to botanists. The Type-basis Code was published in SCIENCE (49: 333. 1919; 53: 312. 1921). The differences were summarized by me in the British *Journal of Botany*. In the above article Mr. Sprague proposes a compromise. Personally I am in favor of a compromise along the lines he suggests. Practically this can best be accomplished at the next International Botanical Congress if the subject has been sufficiently considered previously by the taxonomic botanists of the world.

The question naturally arises, how many adherents of the International Rules are disposed to compromise? Mr. Sprague speaks only for himself. On the other hand, how many adherents of the Type-basis Code are willing to compromise? Being chairman of the Committee on Nomenclature of the Botanical Society of America, I must state plainly that in recording my disposition to compromise I am giving my personal views only.

It can not be expected that botanists will commit themselves in advance of a definite proposition formulated at a Botanical Congress. However, much can be gained in a preliminary way by a discussion. I would suggest that taxonomic botanists in America send me a statement of their views on the compromise suggested by Mr. Sprague.

A. S. HITCHCOCK

U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

SPECIAL ARTICLES

A COMPARISON OF THE MORTALITY OF CERTAIN LOWER ORGANISMS WITH THAT OF MAN[1]

THE appropriate procedure for gaining an adequate scientific description of the mortality in any aggregate of living things is well understood, and has been widely practiced for nearly three centuries by vital statisticians and actuaries. It consists fundamentally in setting up, from observations over a sufficient time, the specific death rates at ages, for a chosen time unit, which unit in the case of man is commonly taken as one year. From these age specific death-rates all other actuarial functions of the mortality, such as survivorship, absolute mortality, expectation of life, etc., are derived, by mathematical procedures which are in essence simple enough, if sometimes complicated in the practical computations.

Now, while all this is well understood, when one embarks upon a comprehensive general biological investigation of the laws of mortality and duration of life, he is presently confronted with a practical difficulty. How shall he compare the mortality of two organisms whose total life spans are so widely different in extent of time that it is in practice quite impossible to measure or express them in the same unit?

In a recent paper Pearl[2] has suggested what appears to be a valid method of dealing with this difficulty, in making a comparison of the mortality of *Drosophila* with that of man. The nature of the solution is indicated in the following quotation from that paper:

> Upon what basis shall any life table function, say l_x, of the *Drosophila* life table be compared with that of man? The life span of one of these organisms is best measured in days, while that of the other is measured in years. This fact, however, offers no insuperable difficulty to the comparison. What is needed is to superimpose the two curves so that at least two *biologically equivalent points* coincide. The best two points would be the beginning and the end of the life span. But in the case of *Drosophila* our life tables start with the beginning of *imaginal* life only. The larval and pupal durations are omitted.
>
> I think we can get at this starting point . . . by putting the human and *Drosophila* l_x curves together as a starting point at the age for each organism *where the instantaneous death rate* q_x *is a minimum.* In the case of *Drosophila,* I think we are safe in concluding, on the basis of the work of Loeb and Northrop as well as from our own observations, that this point is at or very near the beginning of imaginal life. We shall accordingly take *Drosophila* age 1 day as this point. Our life tables show that certainly *after* this time q_x never again has so low a value.

[1] Papers from the Department of Biometry and Vital Statistics, School of Hygiene and Public Health, the Johns Hopkins University, No. 85.

[2] Pearl R.: "Experimental studies on the duration of life. VI. A comparison of the laws of mortality in *Drosophila* and in man." *Amer. Nat.*, Vol. 56, pp. 398-405, 1922.

TABLE I

Observed and calculated q_x values from Noyes's data on Proales.

Days of life	Observed death rate (per 1000) within interval.	Calculated q_x	Calculated l_x (number living at beginning of each interval)
0- .9	0	.06	1000.0
1.0-1.9	1.4	1.39	999.9
2.0-2.9	9.6	9.99	998.5
3.0-3.9	47.3	44.98	988.5
4.0-4.9	136.5	144.60	944.0
5.0-5.9	393.9	349.90	807.5
6.0-6.9	575.9	653.50	525.0
7.0-7.9	1000.0	956.10	181.9
8.0-8.9	.....	.....	80.0
9.0-9.9	.....	.....	0

TABLE II

Survivorship distribution for each centile of the life span of Proales decipiens.

Centile of life span	Number alive at beginning of centile age interval.	Centile of life span	Number alive at beginning of centile age interval	Centile of life span	Number alive at beginning of centile age interval
0- 1	1000	34-35	991	68- 69	655
1- 2	1000	35-36	990	69- 70	630
2- 3	1000	36-37	988	70- 71	605
3- 4	1000	37-38	986	71- 72	579
4- 5	1000	38-39	984	72- 73	552
5- 6	1000	39-40	982	73- 74	525
6- 7	1000	40-41	979	74- 75	497
7- 8	1000	41-42	976	75- 76	469
8- 9	1000	42-43	973	76- 77	440
9-10	1000	43-44	969	77- 78	411
10-11	1000	44-45	965	78- 79	382
11-12	1000	45-46	960	79- 80	354
12-13	1000	46-47	955	80- 81	326
13-14	1000	47-48	950	81- 82	298
14-15	1000	48-49	944	82- 83	270
15-16	1000	49-50	937	83- 84	244
16-17	1000	50-51	930	84- 85	218
17-18	1000	51-52	922	85- 86	194
18-19	999	52-53	914	86- 87	171
19-20	999	53-54	905	87- 88	149
20-21	999	54-55	895	88- 89	128
21-22	999	55-56	884	89- 90	109
22-23	999	56-57	872	90- 91	91
23-24	999	57-58	859	91- 92	75
24-25	998	58-59	845	92- 93	61
25-26	998	59-60	830	93- 94	49
26-27	997	60-61	815	94- 95	38
27-28	997	61-62	799	95- 96	28
28-29	996	62-63	782	96- 97	20
29-30	996	63-64	763	97- 98	13
30-31	995	64-65	743	98- 99	8
31-32	994	65-66	723	99-100	4
32-33	993	66-67	701	100	1
33-34	992	67-68	678		

For the other end of the life span we may conveniently take the age at which there is left but *one* survivor out of 1,000 starting at age 1 day for *Drosophila* and age 12 years for white males.

When the above was written we were aware of the existence of complete life tables for only the two organisms *Drosophila* and man. Since then we have calculated a life table for a third form, the rotifer *Proales decipiens*, on the basis of data as to its mortality recently published by Dr. Bessie Noyes.[3] We wish to report the

[3] Noyes, B.: "Experimental studies on the life-history of a rotifer reproducing parthenogenetically *(Proales decipiens)*. *Jour. Exp. Zool.*, Vol. 35, pp. 225-255, 1922.

results here, and to compare them with the data for the other two organisms.

Miss Noyes provides in her paper, in two different but apparently homogeneous series, data on the life history of 1,454 individuals. The observations were taken only once in 24 hours, an interval far too long to give a smooth curve for an animal having a maximum total life span of only about eight days. This fact makes the construction of a life table more difficult and much less accurate than if the observations had been more closely spaced. It is as though one tried to construct a life table for man from data as to age at death recorded only to the nearest decade.

Taking the data as they stand, however, the central death-rates were computed and graduated with the results shown in Table I.

The q_x values were graduated by the following expression (with origin at 0 age, or birth)

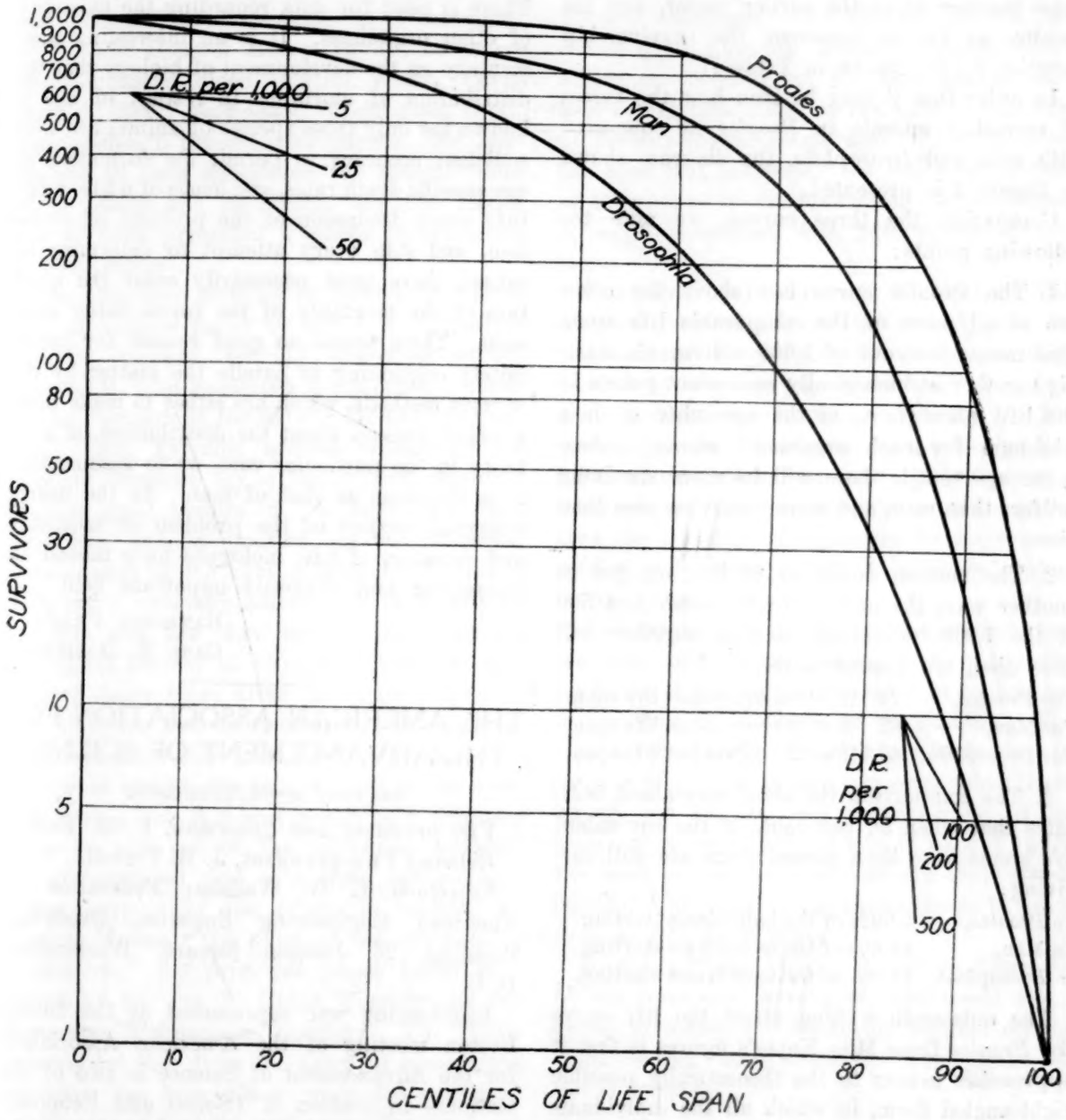

FIG. 1. Showing survivorship distributions for (*a*) rotifer *Proales decipiens*, (*b*) man (males in original registration states, 1910), and (*c*) *Drosophila melanogaster* (wild type males). The death rates corresponding to given slopes of the l_x line are also given by the groups of fine lines at the two ends of the diagram.

which is of a type found useful in previous work with *Drosophila* life curves:

$$\log q_x = -1.0783 + .7041x - .0452x^2 + 1.5080 \log x.$$

It is evident from the data of Table I that the fit is reasonably good, probably as good as one could expect with observations so rough in respect of age at death.

The next step is to calculate a *Proales* life table in terms of centiles of the life span rather than in absolute age. This was done in the same manner as in the earlier paper, and the results, so far as concerns the survivorship function l_x, are shown in Table II.

In order that it may be seen how the forces of mortality operate in *Proales* as compared with man and *Drosophila*, the diagram shown as Figure 1 is presented.

Comparing the three curves, we note the following points:

1. The *Proales* curve lies above the other two at all parts of the comparable life span. This means that out of 1,000 individuals starting together at biologically equivalent points in the life span (*i. e.*, at the age when q_x is a minimum for each organism) at any subsequent age centile there will be more surviving rotifers than men, and more surviving men than flies.

2. The median durations of life, or, put in another way, the ages prior to which just 500 of the 1,000 individuals starting together will have died, are approximately:

For *Proales*,	74 % of the equivalent life span.
For Man,	62 % of the equivalent life span.
For *Drosophila*,	42.5% of the equivalent life span.

3. The comparison the other way about indicates that when 50 per cent. of the equivalent life spans have been passed there are still surviving:

In *Proales*,	93.0% of the individuals starting.
In Man,	68.5% of the individuals starting.
In *Drosophila*,	38.0% of the individuals starting.

The outstanding thing about the life curve for *Proales* from Miss Noyes's figures is that it approaches nearer to the theoretically possible right-angled form, in which all the individuals live to a given age x and then all die at once, than any other that has yet been observed. Whether this is the result of (*a*) the greater uniformity of environment, on the average, for the *Proales* under the experimental conditions than for the other forms, or (*b*) the greater uniformity of the population in genetic constitution, consequent upon the fact that *Proales* reproduces parthenogenetically and that all of Miss Noyes's cultures were descended from at most not over six different individuals, or (*c*) a combination of both, can not be definitely stated. Both of the factors mentioned undoubtedly do in some degree operate to produce the form of life curve exhibited. There is need for data regarding the mortality of other organisms. It is an interesting commentary on the development of biology that the distribution of mortality in respect of age is known for only three species of animal life with sufficient accuracy to permit the formation of age-specific death rates, and hence of a life table. Into every discussion of the problem of evolution, and into every attempt to determine its causes, there must necessarily enter the question of the mortality of the forms being dealt with. There seems no good reason for indefinitely continuing to handle the matter by the current methods, which are either to make large *a priori* guesses about the distribution of mortality in the particular case, or to assume that it is the same as that of man. In the nearly universal neglect of the problem of mortality and duration of life, biologists have missed an interesting and obviously important field.

RAYMOND PEARL
CARL R. DOERING

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION M—ENGINEERING

Vice-president and Chairman, F. M. Feiker.
Retiring Vice-president, J. B. Tyrrell.
Secretary, L. W. Wallace; Federation of American Engineering Societies, Brookings Building, 26 Jackson Square, Washington, D. C.

Engineering was represented at the fourth Boston meeting of the American Association for the Advancement of Science in two of the sections—in Section K (Social and Economic Sciences), of which Dr. Henry S. Graves, of the Yale Forest School, Yale University, is vice-president and chairman, and in Section M (Engineering), of which Mr. F. M. Feiker,

vice-president, McGraw-Hill Company, Inc., New York, is vice-president and chairman.

The keynote of the joint session between Section M and Section K was "The relation of the engineer to conservation." John T. Black, State Health Commissioner, Hartford, Conn., presented a paper on conservation with reference to industrial waste; William S. Murr, of New York City, spoke on the conservation of power. Due to badly delayed train schedules, both Mr. O. C. Merrill, secretary of the Federal Water Power Commission, Washington, D. C., and General Harry Taylor, in charge of Government Flood Control Works, Corps of U. S. Army Engineers, Washington, D. C., were unable to present their papers. Mr. Merrill was to have spoken on the federal water power policy and its results, and Dr. Taylor was to have presented a paper on problems of flood control.

The afternoon meeting of Section M opened with an address paper by Mr. J. B. Tyrrell, of Toronto, Canada, retiring vice-president for Section M, who presented a remarkable paper on the "Growth of the mining industry in Canada." Mr. Tyrrell's address constituted an effective summing up of the mineral resources of that great section of the North American continent, and he pointed out the historical development of the mining industry in Canada with many dramatic allusions to early mining ventures and the later surveys made by the Geological Survey of Canada. Gold was discovered many years after the earlier explorers and trappers had overlooked it. In one case on the Hudson Bay trail the feet of the trappers wore smooth the vein of gold in the rock, and during the fall and winter the trappers going in and out of the wilderness polished the undiscovered vein with their moccasins.

The keynote of the afternoon meeting of Section M was "The place of the engineer in civilization," the principal paper being presented by Dr. Ira N. Hollis, president of the Worcester Polytechnic Institute. Dr. Hollis pointed out that from the dawn of history the emphasis has been placed upon the man who produces, and that the root names for producer in several of the earlier languages are synonymous with our definition of the term *engineer*. One phase or another of engineering activity enters into practically all the other arts and sciences. Doctor Hollis instanced the factor of transportation and communication as one vitally touching life and activities of men in all walks of life, and pointed out the engineer's place in the further development of transportation and communication systems in the world. Mr. Tyrrell, retiring vice-president, in his address, referred to the part that steam railway transportation has played in the development of the mining industry as a practical illustration of the engineer's place in utilizing our natural resources. Dr. Hollis, as did Mr. Warrington Emerson, another speaker of the afternoon, pointed out the need of the engineer's analytical study of facts for the solution of present-day problems, and both emphasized the idea that indirectly the engineer, because of his control of the instrument of production, is deeply concerned with present-day civilization.

The paper by Professor C. F. Scott, of Yale University, president of the Society for the promotion of Engineering Education, on "New phases of engineering education," was presented in Professor Scott's absence by Dr. Dugald C. Jackson. Professor Scott indicated that because engineering was coming to take such a large place in our modern life, it was essential that the training of engineers be approached with a new viewpoint of the engineer's place in the community.

The several contributions emphasized that the next step in engineering is to relate the problems of the material advance in civilization to the human problems of civilization. The engineer has an opportunity for leadership in approaching these human problems, which have grown out of his own contributions in increasing the perplexity of life, if he will apply the logic of his thinking with the understanding that human problems are problems of emotion, as well as of logic.

In the evening Calvin W. Rice, Secretary of the American Society of Mechanical Engineers, presented an illustrated address on the "Engineering and scientific development of South America."

SECTION N—MEDICAL SCIENCES

Vice-president and Chairman, Francis Weld Peabody.

Retiring Vice-president, A. B. Macallum.

Secretary for the Boston Meeting, A. J. Goldfarb; College of the City of New York, New York, N. Y.

(*Report by A. J. Goldfarb*)

Following a plan recently adopted by the section, there was held on Friday afternoon a session of invited papers on parasitology and entomology as these subjects are related to medical science. The new plan contemplates the bringing together of a group of men of science not specially provided for in any other organization, and it emphasized the unity of science in general. Somewhat as the geneticists of the Botanical Society of America and of the American Society of Zoologists have organized the Joint Genetics Section, it is planned that Section N may serve a very useful purpose to American science by bringing together research workers in the various scientific fields that contribute to medical science. This movement, together with the recent formation of the genetics section just mentioned, illustrates a new tendency in scientific organization, to form groups on the basis of fundamental relationships in the scientific results to be achieved and the general methods to be employed, rather than simply on the basis of the classification of the organisms or materials studied.

The new plan for Section N was first tried in the session at Boston. The program for that session was based on the fundamental relationships that hold between certain fields of medical science and those of parasitologists and entomologists. Dr. A. B. Macallum, of McGill University, retiring vice-president for the section, gave the vice-presidential address on "The necessity for advanced research on the intestinal mucosa, the great gateway of disease of the body," and medical science was also represented by Dr. Richard P. Strong, of the Harvard Medical School, who presented an invitation paper on "Some aspects of disease associated with the fields of zoölogy, entomology and parasitology." Entomology was represented by invitation papers by Dr. C. T. Brues, of the Bussey Institution, and by Dr. L. O. Howard, of the U. S. Department of Agriculture. Dr. Brues brought out the interesting fact that evidence is very strong for regarding poliomyelitis (infantile paralysis) as being spread mainly by rats and insects. Dr. C. A. Kofoid, of the University of California, and Dr. C. W. Stiles, of the U. S. Public Health Service, represented parasitology by invitation papers. The former spoke on "Incidence of the human intestinal protozoan infections in the United States," and the latter considered "Some medico-zoölogical phases of our immigration problems." Each speaker dealt on the inter-relations among the allied fields represented in the program, suggesting problems that might well be considered by those in related fields outside of his own. The program as a whole furnished an excellent example of the recent emphasis on the need of cooperation among scientific men.

The session was very well attended, there being 120 persons present, and great interest was manifest. It was voted that the general plan here tried for the first time should be adhered to for the future work of Section N.

SECTION O—AGRICULTURE

Vice-president and chairman, R. W. Thatcher.

Retiring vice-president, Jacob G. Lipman.

Secretary, P. E. Brown, Iowa State College, Ames, Iowa.

(*Report by P. E. Brown*)

Section O of the association met on Wednesday afternoon of the Convocation Week with an invitation program by representatives of various of the societies affiliated with the section. The address of the retiring vice-president for the section was given by Dr. J. G. Lipman, of the New Jersey Agricultural Experiment Station. Dr. Lipman read a paper on "Tendencies in agricultural research." He discussed the subject in a most comprehensive way, calling attention to the accomplishments of the past years, the demands of the present, the causes for these demands, and the way in which research is meeting the complicated problems of present-day agriculture. Dr. C. V. Piper presented a paper on "The forage situation in the United States," in which he discussed forage production in its broad relation to agriculture and emphasized the significant aspects of forage crop problems. Professor E. N. Wentworth discussed "The relation of genetics to the business of agriculture," showing the significance of the problems that the livestock interests have called upon the geneticists to

solve. Dr. B. L. Hartwell enumerated some of the crop production problems which need attention and which are characterized by the title of his paper, "Between the lines of science in crop production." Dr. T. L. Lyon gave a paper entitled "A note on the correlation of crop response to potassium and calcium in certain soils."

President R. A. Pearson, of the Iowa State College, was elected vice-president and chairman for the section, and Dr. H. J. Wheeler, of Boston, was elected to the section committee. The section voted to affiliate with the Union of Biological Societies.

THE AMERICAN SOCIETY OF AGRONOMY

President, S. B. Haskell.

Secretary, P. E. Brown, Iowa State College, Ames, Iowa.

(Report by P. E. Brown)

The American Society of Agronomy held its winter meeting on Friday of the Convocation Week, with an attendance of about seventy-five. The program consisted of a symposium on "Soil toxicity in its relationships to economic crop production," arranged by B. L. Hartwell. Ten papers were presented on various phases of the toxicity problem—particularly organic and inorganic compounds, acidity, susceptibility, methods of diagnosis, immunity and some physiological aspects of the problem. The speakers included Dr. Oswald Schreiner, Dr. A. L. Whiting, Dr. A. G. McCall, Professor F. W. Morse, Dr. P. L. Gile, Dr. W. P. Kelley, Dr. G. N. Hoffer, Dr. R. W. Thatcher and Dr. B. E. Livingston. The program continued throughout the day, and lively discussions followed each paper, interest centering especially on the problems of soil acidity and the relation of aluminum to toxicity.

A joint dinner with Section O, arranged by a committee of the New England agronomists, was given at the Boston City Club on Thursday evening. About forty-five attended and enjoyed a carefully planned New England dinner. An extensive program was presided over by Dr. C. R. Ball, toastmaster.

Director S. B. Haskell, president of the society and local representative, was largely responsible for the success of the dinner and of the meeting.

THE AMERICAN SOCIETY FOR HORTICULTURAL SCIENCE

President, J. C. Blair.

Secretary, C. P. Close, College Park, Md.

(Report of C. P. Close)

Professor J. H. Gourley, of the Ohio Agricultural Experiment Station, Wooster, Ohio, was elected president of the society for 1923. The following were elected as vice-presidents: Professor G. F. Potter, Durham, N. H., Professor H. A. Jones, Berkeley, Calif., and Professor T. G. Bunting, Macdonald College, Quebec. Professor C. P. Close was elected (to succeed himself) as secretary, and Professor R. E. Marshall was elected assistant secretary.

The society met in Room 2-180, of the Massachusetts Institute of Technology, the sessions beginning Wednesday morning, December 27, and continued through Friday afternoon. The program included fifty-nine papers, of which two reported studies on light relation, seven studies on temperature relations, ten teaching and extension work, eleven vegetable studies, nine breeding work and twenty studies in pomology.

THE SOCIETY OF AMERICAN FORESTERS

President, E. A. Sherman.

Secretary, W. N. Sparhawk; U. S. Forest Service, Washington, D. C.

(Report by W. N. Sparhawk)

The meetings of the Society of American Foresters on December 29 and 30 were the most successful ever held, both as regards attendance and interest and discussion of papers. The total attendance included more than 130 members and guests. Perhaps the most significant fact brought out at the meetings, as well as at those of the joint sessions with the New England Forestry Congress, was that in the northeastern states, at least, the time is now ripe for the application of technical forestry on a wide scale. Not only is systematic timber-growing desirable from the standpoint of general public welfare, but conditions have reached the point where it is a paying proposition for private individuals and corporations.

Resolutions were adopted urging the early establishment of forest experiment stations in

New England and the Lake states; continued acquisition by the Federal government of forest lands, under the Weeks Law; increased State and Federal appropriations for forest fire protection; and the following:

Whereas, After a long career of distinguished service, Dr. Hopkins has resigned as chief of the Division of Forest Insects in the United States Bureau of Entomology, and

Whereas, The depredations of forest insects constitute a vital factor in the problems confronting the forester, be it

Resolved, That the Society of American Foresters recommends the appointment of an entomologist who, in addition to thorough technical training, possesses a rich practical experience in economic forest entomology and a close familiarity with the problems and methods of forest management.

The following officers were elected: *President,* Professor Ralph S. Hosmer, Cornell University, Ithaca, N. Y.; *Vice-president,* Professor Herman H. Chapman, Yale University, New Haven, Conn.; *Secretary,* William N. Sparhawk, U. S. Forest Service, Washington, D. C.; *Treasurer,* Fred W. Besley, State Forester, Baltimore, Md.; *Member of Executive Council (for five years, 1923-27),* Robert Y. Stuart, Forest Commissioner, Harrisburg, Pa.

THE SOCIETY FOR THE PROMOTION OF AGRICULTURAL SCIENCE

President, R. W. Thatcher.

Secretary-Treasurer, P. E. Brown, Iowa State College, Ames, Iowa.

(Report by P. E. Brown)

This society held a brief business session on Thursday afternoon and, after some discussion, voted to merge the society with Section O of the association, the details of the merging to be arranged by the officers of the society who fill corresponding offices in the Section.

GENETICISTS INTERESTED IN AGRICULTURE

Secretary, Edward N. Wentworth, Armour's Bureau of Agricultural Research and Economics, Chicago, Ill.

(Report by E. N. Wentworth)

Geneticists interested in agriculture met Wednesday morning preceding the meeting of the Genetics Sections of the American Society of Zoologists and the Botanical Society of America. The general topic of discussion was "The place of genetics in the agricultural experiment stations." Dr. John W. Gowen, of the University of Maine discussed "The future possibilities for fundamental research in the experiment stations." He called attention to the growing difficulties of financing the stations based on the lowered purchasing price of the dollar, the consequent limitation of funds for research purposes and the increasing pressure from the outside for research giving promise of immediate results in the hope of offsetting the agricultural stringency. Dr. E. W. Lindstrom, of the Iowa State College discussed "The relation of the genetics department to the applied departments." He called attention to the difficulty of making genetic problems fit into the research program of the applied departments and at the same time stressed the fact that requests could not be made for a broad duplication of equipment for animal and plant breeding in order that the genetic research might proceed without interruption. His final decision was that the geneticists must be equipped for applied research in some one field and cooperate by advice and research assistance in other fields. The geneticists interested in agriculture form a temporary organization only, holding meetings at times when live topics of discussion exist, and dealing particularly with problems of organization and procedure in the agricultural colleges. The secretary *ad interim* for 1923 is Dr. E. W. Lindstrom, Iowa State College, Ames, Iowa.

THE POTATO ASSOCIATION OF AMERICA

President, J. G. Milward.

Secretary, William Stuart, U. S. Department of Agriculture, Washington, D. C.

(Report by William Stuart)

The annual meeting of the Potato Association of America, which was held at the Massachusetts Insitute of Technology, December 27-29, 1922, proved to be one of the most interesting meetings thus far held by this association.

One of the worth-while features of this meeting was that of the joint session held by the association with that of the Phytopathological Society for the purpose of a free discussion of seed potato certification standards. Owing to lack of time the chairman of this conference

found it impossible to cover the whole subject involved in seed certification work, thereby making it necessary to postpone its completion until the following afternoon. While no definite action was taken regarding the adoption of uniform inspection rules, it is believed that the ultimate good resulting from this conference will serve to very materially aid in the conduct of this work.

The attendance, while not large at any given session, except the one devoted to a joint conference with the pathologists, was largely made up of persons intensely interested in the improvement of the potato industry. The papers presented and the discussion they evoked were brief, snappy and very much to the point.

The following resolutions were presented by the Resolutions Committee and unanimously adopted by the members present:

Whereas, We feel that the specific functions of this association as stipulated in the constitution can be more efficiently and more fully carried out by closer connection and cooperation with all potato organizations of the United States and Canada; be it therefore

Resolved, That we invite all such organizations to take out memberships for its officers or executive boards and wherever practicable to send at least one delegate to our annual meeting; and be it further

Resolved, That such delegates bring to the meeting their local and regional problems in order that they may be brought to the attention of the specialists best fitted to deal with them. Be it further

Resolved, That this association desires to express its appreciation of the courtesies extended to it by the Massachusetts Institute of Technology and that a copy of this resolution be transmitted to the proper authorities.

At the conclusion of the afternoon session, Friday, Decembebr 29, the following officers were elected for the ensuing year: *President,* Dr. W. H. Martin, Experiment Station, New Brunswick, N. J.; *Vice-president,* G. C. Cunningham, Agricultural Department, Fredericton, N. B.; *Secreary-treasurer,* W. Stuart, U. S. Department of Agriculture, Washington, D. C.; *Assistant Secretary-treasurer,* W. M. Peacock, U. S. Department of Agriculture, Washington, D. C.

The Executive Committee consists of the president, vice-president, secretary-treasurer, the retiring president, J. G. Milward, Experiment Station, Madison, Wisconsin, and H. R. Talmage, Riverhead (L. I.), N. Y.

SECTION Q—EDUCATION

Vice-president and Chairman, Bird T. Baldwin.

Retiring Vice-president, Guy M. Whipple.

Secretary, A. S. Barr, 1924 Hazelwood, Detroit, Mich.

(No report received. The permanent secretary has been obliged to supply what follows.)

Five sessions of Section Q were held, in the Fogg Art Museum of Harvard University, on Wednesday, Thursday and Friday forenoons, and on Wednesday and Thursday afternoons. The first session was addressed by J. C. Manry, University of Iowa, A. I. Gates, Columbia University, and W. F. Dearborn, Harvard University. Informational education and international affairs were discussed.

The second session, held jointly with the honor society, *Phi Delta Kappa,* gave special attention to needed research in elementary, secondary and college education, with papers by William S. Gray, University of Chicago, George S. Counts, Yale University, and Leonard Koos, University of Minnesota. S. A. Courtis and Charles L. Spain, both of the Detroit public schools, spoke on the selection of judges for judgment scales and the platoon organization, respectively.

At the third session were presented papers on rating, by Charles H. Bean, Louisiana State University, and F. A. Kingsbury, University of Chicago. Frank N. Freeman, University of Chicago, spoke on the value of motion pictures in the teaching of writing, with interesting illustrations showing groups of children in good and poor positions for handwriting. Groups to whom these films had been shown advanced much more rapidly in this respect than did other children who had not seen the films. Willis L. Uhl, University of Wisconsin, reported on a recent attempt to develop an improved set of standards for the selection of material for reading and literaure in elementary and high schools. Over 7,000 reading selections were judged by over 3,000 teachers. The main objectives are: mastery of the mechanics of reading, comprehension of what is read, and development of literary culture.

At the fourth session was given the retiring address of Guy M. Whipple, of the University of Michigan, retiring vice-president of the American Association for the Advancement of Science for Section Q. This was followed by a business session, at which Dean Henry W. Holmes, of Harvard University, was nominated to the council for chairman of the Section and vice-president of the American Association for the Advancement of Science for 1923. A. S. Barr was nominated to the council for secretary of the section for the remainder of the term, which ends at the close of the Washington meeting, December, 1924. The newly elected members of the Section Committee for Section Q are: Wm. S. Gray (retiring 1926), School of Education, University of Chicago, and Guy M. Whipple (retiring 1925), School of Education, University of Michigan.

The fifth session dealt largely with tests of intelligence, character, etc., with papers by J. M. Brewer, Harvard University; O. R. Chambers, Ohio State University; and others.

SECTION X—SCIENTIFIC SOCIETIES RELATED TO THE AMERICAN ASSOCIATION IN GENERAL

Society of Sigma XI.

President, Henry B. Ward.

Secretary, Edward Ellery; Union College, Schenectady, N. Y.

(*Report by Edward Ellery.*)

The annual American convention of Sigma XI was held in connection with the meetings of the Association for the Advancement of Science, December 27. The business session convened at 2:30, the president, Professor H. B. Ward, of the University of Illinois, presiding. Thirty-two of the thirty-nine chapters were represented by delegates, this being the largest number of delegates ever registered at a convention of the society. The chief items of business were petitions for chapters from the University of Oregon and Swarthmore College and the consideration of a new constitution. Both petitions for charters were granted. The new constitution, as proposed at the convention of a year ago, was adopted with minor changes and provides for a simpler classification of members and a closer union of alumni members with the active organization.

The annual dinner was held in the Walker Memorial with 170 in attendance. President Ward acted as toastmaster and introduced President Moore of the association, President Farrand of Cornell University, Professor Stafford of the University of Oregon, Professor Marriott of Swarthmore and Professor Webster of Clark University.

The first annual Sigma Xi public lecture given in a joint meting with the association was delivered by President Farrand of Cornell University in the main building of the Institute of Technology. Dr. Farrand chose for his topic "The nation and its health." He was enthusiastically received by a large audience.

Professor F. K. Richtmyer, of Cornell University, was re-elected a member of the executive committee.

Phi Kappa Phi

President General, J. S. Stevens.

Secretary General, L. H. Pamnel, Ames, Iowa.

An informal business meeting formed the only session of this society.

Sigma Delta Epsilon

President, Christianna Smith.

Secretary, Evelyn Fernald, Ithaca, N. Y.

Sigma Delta Epsilon, Graduate Women's Scientific Fraternity, held its first National Convention at the Boston meetings. Amendments to the constitution were recommended by the convention, and membership qualifications and expansion were discussed. A luncheon was held for those interested at The Hotel Essex on December 28, at which Mrs. Anna Botsford Comstock and Miss Christianna Smith spoke on the need of organization among women and what had been accomplished by the two chapters at Cornell University and the University of Wisconsin.

The following national officers were elected at the convention: *President,* Miss Christianna Smith, Dept. of Histology and Embryology, Cornell Univ., Ithaca, N. Y.; *First Vice-president,* Dr. Elizabeth Smith, Dept. of Zoology, Univ. of Wisconsin, Madison, Wis.; *Second Vice-president,* Miss C. Audrey Richards, U. S. Dept. of Forest Pathology, Madison, Wis.; *Secretary,* Miss Evelyn I. Fernald, Dept. of Botany, Cornell Univ., Ithaca, N. Y.; *Treasurer,* Miss Helen Johann, U. S. Dept. of Plant Pathology, Madison, Wis.